Human Impact on Portugal's Vegetation

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Portugal, with an area of 9 million ha, is a country small in size but rich in vegetation diversity and human history. The interaction of vegetation and human activity has resulted in complex land use problems. The Iberian Peninsula has a greater number of native flowering plant species than other portions of Europe due to its mild, moist winters and warm, rainless summers (Polunin and Walters 1985). The Tagus River runs west from Spain to Lisbon and divides Portugal into 2 regions of nearly equal size. The region south of the Tagus River is influenced by a Mediterranean climatic and characterized by rolling hills: less than 0.2 percent of the area exceeds 700 m in elevation. The region north of the Tagus River has distinctly different features. The influence of the Atlantic Ocean is greater, which, in conjunction with the mountainous topography, results in a more humid and dissected landscape. More than 20 percent of the area is above 700 m. Limestone and schists predominate southern Portugal, while the northern "Meseta" (plateau) is composed of granites and schists. Historical land ownership patterns are also different. In the South, communal lands were appropriated by individuals, while in the North they still represent over 25 percent of the area in some districts. Most of the current rangelands are located on the communal lands.

Pristine Vegetation

Climax vegetation is as diverse as the landscape. Glaciation did not have the detrimental influence on species richness in Portugal that it had on most regions of Europe. Many tree species that were once present in Portugal (members of the genera *Sequoia, Picea,* and *Fagus*) became extinct during the glacial advances; southern Portugal was one of the refuges for many species endangered in Europe during those periods. The entire Iberian Peninsula was forested or wooded during the last glacial period that ended 10,000 years ago (Polunin and Walters 1985). Primary succession following glaciation probably began with communities of shrubs which were gradually dominated by pines *(Pinus sylvestris, P. pinaster)* and birches *(Betula* spp.). These were more recently replaced by oak (*Quercus* spp.) forests with associated species such as chestnut *(Castanea sativa).*

Differences in topography, parent material, and climate within the country are responsible for the distribution of the potential climax communities defined by Braun-Blanquet et al. (1956) (Fig. 1). In northern Portugal, with the exception of the Douro River Valley, the climax vegetation, the *Quercion occidentale* alliance, is dominated by deciduous oaks *(Quercus robur, Q. pyrennaica)* (Fig. 2). Above timberline of the highest mountain ranges, Serra da Estrela and Serra do Geres, the *Juniperion nanae* alliance developed which includes a montane form of juniper *(Juniperus communis* var. *nana)* (Fig. 3). Southern Portugal and the Douro River Valley in the North are dominated by the *Quercion fagineae* alliance of evergreen oaks: cork oak *(Q. suber)* and holly oak *(Q. rotundifolia).* The semi-deciduous Portuguese oak *(Q. faginea)* was probably abundant, but it is now generally absent due to lower fire resistance and minimal economic value. Finally, in a small band along the coast south of Lisbon, the more typical Mediterranean vegetation composed of sclerophyllous shrubs and trees such as olive *(Olea europaea* var. *oleaster),* carob *(Ceratonia siliqua)* and mastic tree *(Pistacia lentiscus),* forms the *Oleo-ceratonion* alliance (Fig. 4).

Fig. 1. *Potential climax vegetation of Portugal as defined by Braun-Blanquet et al. (1956).*

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Fig. 2. *Deciduous oak forest in Geres National Park in northern Portugal. Primary overstory species include Pyrenean oak* (Quercus pyrennaica) *and pedunculate oak* (Q. robur). *Common understory plants occurring with the oaks are medronho* (Arbutus unedo) *and arboreal heath* (Erica arborea).

Fig. 4. *Typical Mediterranean vegetation of the* Oleo-ceratonion *alliance of the Serra da Arrabida south of Lisbon. Common species of this vegetation include members of the genera* Erica, Quercus, *and* Cistus.

Human factors affecting vegetation

The current vegetation of Portugal has been strongly influenced by humans since Neolithic times. Many successive cultures dominated the region throughout history. The Portuguese portion of the Iberian Peninsula was occupied by the Lusitanians with well-developed cities and established agriculture by the 8th century BC. They were followed by the Carthaginians (200–100 BC), Romans (100 BC to 400 AD), and the Moors (900–1400 AD). Particularly southern

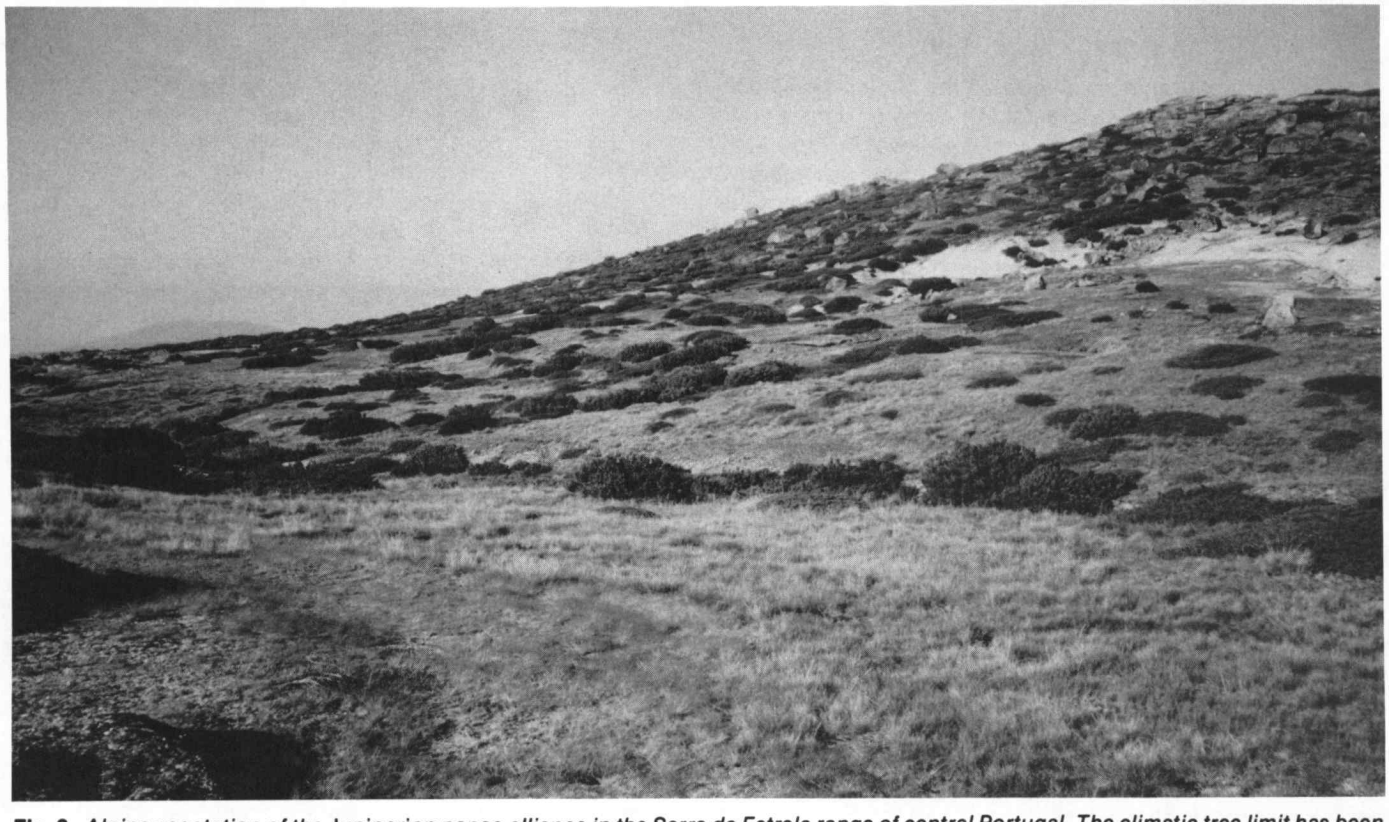

Fig. 3. *Alpine vegetation of the* Juniperion nanae *alliance in the Serra da Estrela range of central Portugal. The climatic tree limit has been lowered by clearing, fire or grazing. This range forms an east-west barrier and is the northern limit of the Mediterranean climate in Portugal.*

Portugal was strongly influenced by the Moors who occupied it until 1249, when they were finally driven out. This Moor influence can be perceived in the people, architecture, music, geographic names such as Algarve, Alentejo, Alcacer, Alcantara, etc. Each culture introduced a variety of agricultural and trade systems as well as numerous exotic plants, and all have left their imprint on the landscape and vegetation. Many species are suspected to have been introduced during these periods but the exact origin of many is not known. For some species it may even be unknown whether they are native or introduced. Rye *(Secale cereale)* and other cultivated grasses were introduced from Asia and were common in central Portugal by 100 BC. The Romans introduced cultivated varieties of olives *(Oleo europaea* var. *europaea)*. However, wild olive varieties were probably present in the native flora (Van Den Brink and Janssen 1985).

Returning Portuguese explorers of the 15th century brought new species back from Asia, Africa, and the Americas; and importation of exotic plants has continued to the present (Caldas 1978). During this period, plants from the Americas such as Douglas-fir *(Pseudotsuga menziesii)*, redwood *(Sequoia sempervirens)*, lodgepole pine *(Pinus contorta)*, agave *(Agave americana)*, pricklypear cactus (*Opuntia* spp.), and numerous oaks have been introduced. Other species such as eucalyptus (*Eucalyptus* spp) from Australia and acacias (*Acacia* spp) from East Africa were imported during recent times.

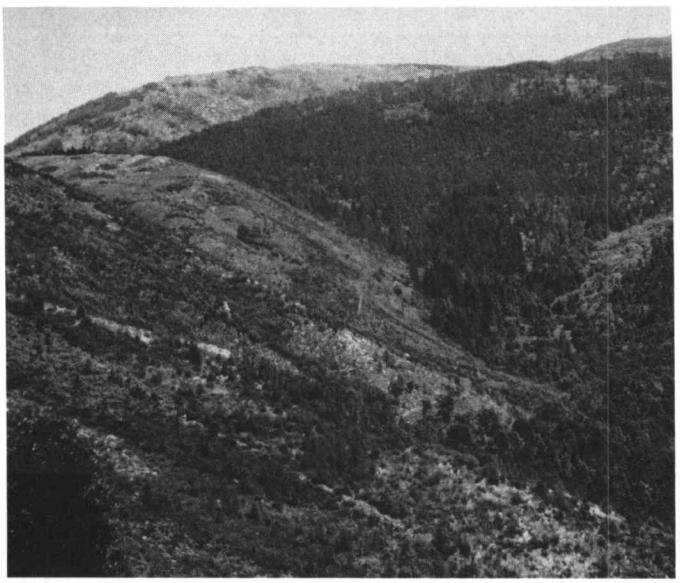

Fig. 5. *Landscapes often include a mosaic of recently burned vegetation such as this area near Cabeceiras. Portion on left side in photograph was burned in two separate fires. The foreground burned about 10 years ago and the central portion 1 year prior to the photograph. Forested area on right side is a 40-year-old maritime pine plantation.*

Fig. 6. *Cork oak near Frontiera in southern Portugal. Cereal crops are cultivated in the tree interspaces during winter. These areas are also grazed by livestock during summer and fall.*

Fires have been used extensively by man during the warm and dry Mediterranean summers to assist in hunting, grazing, agriculture, and warfare. There is evidence that man burned the forests to improve pastures in the Mediterranean Basin since at least the Iron Age, 2,600 years ago (Le Houerou 1973). Fire, wood cutting, and grazing were so common by the Medieval period that the upper tree limit on mountain ranges such as Serra da Estrela was lowered several hundred meters and the forest vegetation was replaced by heath and juniper. This heath and juniper vegetation has been maintained to the present time (Van Den Brink and Janssen 1985). Prescribed fire is currently used extensively to improve the forage value of shrublands, remove crop residue from fields, and for other agricultural applications. Wildfires are common and are primarily man-caused (Fig. 5). During the period 1976 through 1985 an average of 41,000 ha was burned by wildfires each year. This is about 1 percent of the total forested and shrubland area of Portugal and greater than the area that is normally reforested annually (Rego 1986, Silva 1981). The majority of plant species are fire tolerant due to thick bark (maritime pine *(Pinus pinaster),* stone pine *(P. pinea),* cork oak), sprouting capability (oaks, chestnut, olives), or abundant seed production (gorse (*Ulex* spp.), cistus (*Cistus* spp.)).

Grazing has been another major factor in the evolution of Portugal's vegetation. Prior to Roman domination of the region, grazing was the main activity of the Lusitanians who lived near Serra da Estrela, (Van Den Brink and Janssen 1985). Livestock grazing was probably encouraged by the Romans and numbers of animals rapidly increased. A transhumance migration pattern developed which utilized the northern Iberian Peninsula and high elevation ranges in the summer with sheep. During the fall and winter, livestock were driven to lower elevations and southern portions of the Peninsula. The winter pasture could be quite distant and migrations of 200 km were common. This system changed dramatically some decades ago when the pastoralists became more sedentary but grazing continues to be an important use of the land. The long history of grazing combined with the frequent fires ignited by the shepherds may be the cause of the relatively simple floristic communities which are present in much of Portugal today.

Most of the herds of cattle, sheep, and goats in the North are small. In southern Portugal the herd size is larger, averaging about 50 cattle or 300 to 500 sheep. Livestock is kept overnight at the farm, or more commonly, in the village. Animals are herded out to the forests and shrublands daily to feed, or forage is cut and brought to the animal. Livestock movement is restricted for several reasons. The animals often provide milk or are used as draft animals and need to be conveniently located. More important, manure is used as field fertilizer and animal confinement concentrates the manure for easy collection.

As a consequence of grazing and fire, most of the forest or shrub communities have been repeatedly disturbed and the vegetal composition changed. Climax oak woodlands have been replaced by shrub communities (Braun-Blanquet et al. 1956). In the South, the evergreen oaks were replaced by cistus and French lavender *(Lavandula stoechas).* This vegetation has been classified as the *Cisto-Lavanduletea.* In the North, the deciduous oaks were replaced by the more water demanding communities of heather (*Erica* spp., *Calluna* spp.) and shrubby legumes such as gorse and carqueja *(Chamaespartium tridentatum).* These communities are referred to as the *Calluna-Ulicetea.* Differences between the two shrub communities are primarily due to climatic factors, but soil and parent material also are a factor.

Other uses have changed the natural landscape. Agriculture occurs where soil and topography permit. Many steep, rocky hillsides have been converted to vineyards. Since the Roman occupation, wheat production has occupied extensive areas, including some land that is marginal for agriculture. In the South, much of the tree cover was removed to allow agricultural mechanization. Cork oak and olive trees remain abundant (Fig. 6) only because of their economic value.

Reforestation and Management Efforts

Degradation of vegetal cover due to agriculture, fires, and overgrazing has long been recognized. During the 15th century AD, it was thought by the king that wildfires in central Portugal caused extensive flooding and erosion in the Tagus River Basin. Laws were enacted to restrict the use of fires near the Tagus River (Neves 1981). Extensive plantations of maritime pine were established in central Portugal to stabilize the sand dunes and prevent flooding. Later these plantations provided wood to support the ship industry involved in the 15th and 16th centuries. In 1939, a vigorous program was initiated to reforest nearly 20 percent of Portugal in a 30-year period using primarily maritime pine. During this period eucalyptus (*Eucalyptus* spp.) were introduced in southern Portugal. These are fast growing, fire resistant species that have since been planted or have spread by natural regeneration into many plant communities. By 1960 Eucalyptus plantations were being established by both private companies and the federal government to increase wood fiber production.

Reforestation is often practiced on the communal shrublands without the cooperation of the local people who are using these lands. In districts where grazing lands are limited, the reforestation effort conflicts with the traditional land use of the local people. Productivity of the shrub and herbaceous layers declines as the tree overstory develops. Until 1974, federal law prohibited domestic livestock grazing on forested communal lands. This law intensified the conflicts between pastoral use of shrublands and reforestation efforts. Grazing continued in most regions because the government was unable to enforce a law prohibiting the traditional land use.

Shepherds normally burned shrub communities every 5 to 8 years and livestock browsed the nutritious sprouts of many shrubby legumes. Reforestation practices not only restricted grazing but increased fire suppression. While wildfires are still a common occurrence in many regions, the fire-free intervals are too short for successful pine establishment. In other areas the fire-free interval is too long to maintain shrub nutritional quality. Reintroduction of fire as a management tool may be helpful in maintaining the productivity of the remaining shrublands and reducing conflicts between grazing and reforestation.

Several different strategies are being used to increase livestock numbers. In the South, planted pastures of subter-

ranean clover *(Trifolium subterraneum)* with orchardgrass *(Dactylis glomerata)* or perennial rye *(Lolium perenne)* have successfully replaced the degraded non-palatable shrub communities. The maintenance of a partial oak cover is beneficial for soil fertility and pasture establishment and is being retained where possible. In the North, establishment of pastures of perennial grasses and legumes, primarily white clover *(Trifolium repens)*, is being attempted with limited success. Infertile soils and inexperience with pasture utilization are problems to be overcome.

Portugal is a small country with a long history of agriculture, pastoralism, reforestation, and fire. These factors have all influenced the present vegetation. Portugal's rangelands have been a focus of conflicting interests throughout its history. Their used as a source of livestock forage has never been officially accepted as a bonafide land use. However, these lands have been used by pastoralists for a millennium, and grazing continues to be important on communal lands today. At the present time Portugal is attempting to increase wood production through reforestation. This often is in direct conflict with livestock use of the area. Consequently, natural resource managers are looking for ways to more fully utilize the resource base, as well as resolve conflicts associated with livestock and wood fiber production.

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Agro-Sylvo-Pastoral Systems in the Iberian Peninsula: *Dehesas and Montados*

Teodoro Marañón

The Iberian Peninsula is located in the west of the Mediterranean Basin, receiving the influence of the Atlantic Ocean with a mild mediterranean climate characterized by cold, wet winters and warm, dry summers. Long-time eroded Paleozoic rocks (schists, granites, and quartzites) are predominant in the western half of the Peninsula, offering a landscape of plains and rolling hills, where soils are shallow, acidic, and nutrient deficient. The physical constraints of the shallow soils and the seasonal droughts make most of these lands unsuitable for intensive farming. Instead a peculiar agro-sylvo-pastoral system, called locally *dehesa* in Spain and *montado* in Portugal, has been historically developed. This system, composed of cleared oak woodlands with an annual grassland understory, covers more than 5,500,000 hectares (Campos 1984, Ruiz 1986).

Oak trees *(Quercus rotundifolia* and *Q. suber)* are pruned periodically to increase the production of acorns and cork, while providing fuelwood, charcoal, and browse. An important rural economy is based on the fattening of *Iberian* pigs with sweet acorns (600–700 kg/ha) (Parsons 1962). The cork oak *(Q. suber)* bark is stripped off every 7 to 9 years. This

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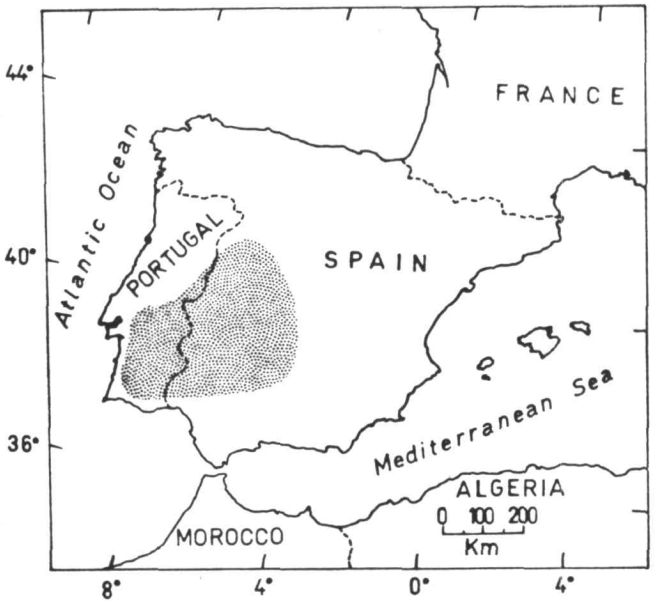

Area of dehesas *and* montados *in the Iberian Peninsula.*